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(34) PURIFIED HEMATOPORPHYRIN DERIVATIVE FOR DIAGNOSIS AND TREATMENT OF TUMORS, AND METHOD.

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CHEMICAL ABSTRACTS, vol. 97, no. 1, July 5, 1982, page 394, abstract 3930s, COLUMBUS, OHIO (US), SHILIN XU et al.: "Hematoporphyrin sodium, as a chemotherapeutic agent", & Zhongcaoyao 1981, 12(8), 343-4.

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Courier Press, Leamington Spa, England.

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Description

This invention relates to photosensitive compounds useful in diagnosis and methods of preparing them.

5 It is known in the prior art to diagnose malignant tumors with photosensitive drugs. In "The Use of a Derivative of Hematoporphyrin in Tumor Detection", J. Natl Cancer Inst. 26:1-8, 1961, Lipson and co-workers disclosed a crude material, prepared by acetic acid-sulfuric acid treatment of hematoporphyrin, said material having a superior ability to localize in tumors. The photosensitive characteristic of tumor-selective porphyrin compounds also make them useful in the treatment of tumors.

10 In "Photoradiation Therapy for the Treatment of Malignant Tumors", Cancer Res. 38: 2628-2635, 1978 and "Photoradiation in the Treatment of Recurrent Breast Carcinoma", J Natl Cancer Inst. 62: 231-237, 1979, Dougherty and co-workers reported using the crude Lipson hematoporphyrin derivative to accomplish photoradiation therapy on human patients. The crude Lipson hematoporphyrin derivative has the ability to enter all kinds of cells and to be retained in tumor cells after it has mostly cleared the serum. 15 Subsequent irradiation with red light excites the crude Lipson derivative which in turn excites oxygen molecules. The excited oxygen molecules exist for a microsecond — long enough to attach to tumor cell walls and effect necrosis.

The crude Lipson hematoporphyrin derivative has the disadvantage of entering normal tissue and causing unacceptable damage when therapeutic light sufficient to treat large tumors is applied. Severe 20 edema and sloughing of healthy skin can occur when the crude Lipson derivative is used. Some patients are even harmed by exposure to ordinary sunlight thirty days following treatment with the drug. A better photosensitizer for treatment of tumors would have no systemic toxicity.

It is a task of the invention to provide a purified photosensitive substance and method of obtaining it.

The new drug is a substantially pure hematoporphyrin derivative being a high molecular-weight 25 derivative, each molecule of which has an empirical formula of $C_{34}H_{35-36}N_4O_{5-6}Na_2$. The drug has absorption peaks in the visible spectrum at approximately 505, 537, 565 and 615 nm, with absorption peaks in the infrared spectrum at approximately 3.0, 3.4, 6.4, 7.1, 8.1, 9.4, 12 and 15 μ m (microns), adsorption peaks in carbon-13 nuclear magnetic resonance study at approximately 9.0, 18.9, 24.7, 34.5, 62, 94.5, 130-145, 171.7 ppm and possibly 118 and 127 relative to a 37.5 ppm resonance peak of dimethyl sulfoxide. 30 The substance shows mass numbers of 1899, 1866, 1809, 1290, 1200, 609, 591, 219 and 149 according to mass spectroscopy and advantageously is in liquid form having a concentration of approximately 2.5 mg/cc. The hematoporphyrin derivative is obtainable by means of specific process steps as outlined below.

Other advantages of the invention will be apparent from the following description, taken in conjunction with the accompanying drawings.

35 The problems underlying the present invention are solved by providing a composition of matter effective for localizing and/or destroying tumors, said composition being fluorescent and photosensitive and having the capability of localizing in and being retained in tumor cells as compared to normal tissues, whereby the composition is comprised of high molecular aggregates of a porphyrine derivative, said composition further having a visible spectrum with absorption peaks at 505, 537, 565, and 615 nm, an 40 infrared spectrum with absorption peaks at 3.0, 3.4, 6.4, 7.1, 8.1, 9.4, 12 and 15 μ m (microns), a carbon-13 NMR resonance spectrum at 9.0, 18.9, 24.7, 34.5, 62, 94.5, 130-145, and 171.7 ppm relative to a 37.5 ppm resonance for DMSO, and a mass spectrum showing mass numbers of 1899, 1866, 1809, 1290, 1200, 609, 591, 219, and 149 obtainable by

- a) reacting hematoporphyrine with acetic/sulfuric acid and precipitating the resulting derivative,
- 45 b) adjusting the pH of an aqueous suspension of said derivative to 7 to 7.4 and
- c) recovering high molecular aggregates of the derivative by filtration through a membrane system excluding substances with a molecular weight below 10,000.

Description of the Drawings

FIGURE 1 is a mass spectrometry print-out of the new drug;
50 FIGURE 2 is a visible light spectrum of the new drug in water solution;
FIGURE 3 and FIGURE 3A in combination illustrate an infra red spectrum of the new drug dispersed in potassium bromide;

FIGURE 4 is a carbon-13 nuclear magnetic resonance print-out of the new drug, referenced to dimethyl sulfoxide.

55 FIGURE 5 and FIGURE 5A in combination illustrate a print-out from a Waters Associates Variable Wave Length Detector used in conjunction with its μ m Bondpak C-18 column, showing various components including a peak formation representative of the new drug.

FIGURE 6 and FIGURE 6A in combination illustrate a print-out from a Waters Associates Variable Wave Length Detector used in conjunction with its μ m Bondpak C-18 column, showing the peak formation of the 60 new drug, per se.

FIGURE 7 is a molecular formula depicting an ether, most likely the unit which associates to form the high molecular weight aggregate of this invention.

65 FIGURE 8 and FIGURE 8A in combination illustrate a carbon-13 nuclear magnetic resonance print-out of the new drug, referenced to tetramethylsilane in deuterated chloroform solvent. Magnification of the spectrum is shown in the ranges from 20-30 ppm and 55-75 ppm.

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(A) Preparation and Purification of the New Drug. (All equipment and reagents must be sterile.)

Add 285 ML of acetic acid to a 1000 ML Erlenmeyer flask containing a Teflon®-coated magnetic stirring bar. Stir the acetic acid and slowly add 15 ML of concentrated sulfuric acid. Weigh out 15.0 grams of hematoporphyrin hydrochloride (preferably obtained from Roussel Corporation, Paris, France) and add said porphyrin to the acid solution. Stir for one hour.

Prepare a solution of 150 grams of sodium acetate in 3 liters of glass-distilled water using a 4-liter glass beaker. At the end of one hour, filter the porphyrin-acid solution, preferably through Whatman No. 1 filter paper, allowing the filtrate to drip into the 4-liter beaker of 5% sodium acetate. The 5% sodium acetate solution now contains a dark red precipitate which is preferably allowed to stand for one hour with occasional stirring. The dark red precipitate is then again filtered, preferably using the above-identified filter mechanism. The filter cake from the filtering process is then washed with glass-distilled water until the filtrate is at pH 5.5—6.0 (1500—2500 ML of wash water may be required). The filter cake is then preferably allowed to dry in air at room temperature.

The air-dried precipitate is ground, using for instance, a mortar and pestle until a fine powder is obtained. The powder may then be transferred to 250 ML round bottom flask. The flask is then attached to a rotating evaporator and rotation under vacuum is maintained at room temperature for preferably 24 hours.

20.00 grams of the vacuum-dried powder is then preferably placed in a 4-liter aspirator bottle which may contain a magnetic stirring bar, and then 1000 ML of 0.1N sodium hydroxide is added thereto. This solution is preferably stirred for one hour and 1N hydrochloric acid is then added dropwise preferably using a buret. The 1N HCL is added until a pH of 7.0—7.4 is obtained and which is stable for 15 minutes. Using for instance the buret readings, the amount of sodium chloride produced from the neutralization of sodium hydroxide by the hydrochloric acid may be calculated.

Isotonic solution is 0.9% NaCl or 9 grams NaCl per liter of solution. Therefore, the amount of NaCl produced during neutralization is subtracted from the amount of NaCl required to make the solution isotonic. The calculated amount of NaCl is then added to the solution, and the solution is stirred for preferably 15 minutes. The quantity of solution should then be brought to a total volume of 4 liters by adding 0.9% NaCl solution.

The aspirator bottle, containing the said solution, is then attached to transfer lines leading to a Millipore Pellicon Cassette system fitted with a 10,000 molecular weight filter pack (Millipore Corporation, Bedford, Mass. 01730). It is preferable that the pH of the solution be 7.0—7.2 during this filtration process, and it is preferable that the temperature of the solution be ambient. The Pellicon cassette system should preferably contain at least 25 liters of isotonic saline solution.

The peristaltic feed pump is turned on and the solution is run through the Pellicon cassette system at a pressure of preferably 0.69—1.38 bar (10—20 p.s.i.g.). Pressure may be varied depending on the flow rate through the system. Saline is added to the system to maintain a volume of 4 liters in the associated aspirator bottle containing the solution.

The filtration process is continued until the solution contains substantially only the high molecular weight, biologically active product. At this time waste monomers are generally no longer present. Exclusion of the waste through the microporous membrane of the filter system is confirmed by analyzing the high molecular weight, biologically active product with a Bio-Gel P-10® column (obtainable for instance from Bio-Rad, Richmond, Ca.) or by high performance liquid chromatography using a μ m Bondpak C-18 column with fixed variable wave length detector (obtainable for instance from Waters Associates, Milford, Ma.), as will be hereinafter described.

Concentrations of the product may be increased by running the Pellicon cassette system without saline feed. Concentrations of the product may be decreased by adding saline solution. It is preferable that concentration of the new drug in solution is approximately 2.5 mg/cc.

(B) Animal Tests of the New Drug

DBA₂ Ha/D mice were transplanted with SMT—F tumors. When the transplanted tumors reached 5—6 mm in diameter, the mice were injected with a dose of 7.5 milligrams of the crude prior art Lipson derivative per kilogram of body weight for comparison purposes. Approximately 24 hours following the injection, the tumor areas of the mice were shaved to remove the fur. The mice were exposed to red light (600—700 nm) (6000—7000 Å) from an arc lamp at an intensity of 160 milliwatts per square centimeter for 30 minutes. Ten of twenty mice showed no apparent tumors seven days after treatment. The injected drug is retained in the tumor cells longer as compared to normal tissue. This protocol was repeated using the new drug disclosed in this invention and equivalent results were obtained but using a drug dose of approximately only one-half (4 mg/kg of body weight), as compared to the prior art Lipson drug. Red light is used in treating tumors by illuminating the same in order to take advantage of the ability of the longer visible wave lengths to penetrate tissue. Illumination may be accomplished by direct illumination or by fiber optics, thus providing for illumination of any portion of the body generally without surgery.

In further tests ICR Swiss (Albino) mice were injected with a therapeutic dose of the crude Lipson derivative (7.5 mg/kg of body weight). Approximately 24 hours following such injection, the hind feet of the mice were exposed to the same light conditions used in the aforescribed tumor response study. The damage to the hind feet was assessed as 2.0 on an arbitrary scale where 0.0 is no damage and 5.0 is complete necrosis. Moist desquamation was evident and the foot area slowly returned to normal after

approximately 40 days. This protocol was repeated using the new drug disclosed in this application in doses of 4 mg/kg of body weight. Only slight erythema and/or edema was noticed following treatment. This condition disappeared after 48—72 hours with no residual effects. This leads us to believe that skin photosensitivity may no longer be a significant problem when using this new drug.

(C) Analysis of the Drug

This new drug, as obtained from the Pellicon system, is a high molecular weight material derived by treating hematoporphyrin hydrochloride with acetic and sulfuric acids followed by appropriate hydrolysis. Its failure to pass through the Milli-Pore Pellicon® 10,000 molecular weight filter pack indicates a molecular weight in excess of ten thousand. Mass spectrometry (FIGURE 1) of the new drug shows especially strong peaks at mass numbers of 149, 219, 591, 609 and characteristic but smaller peaks at 1200, 1218, 1290, 1809.

Spectrophotometry (FIGURE 2) of the new orange-red colored drug in aqueous solution reveals well-defined peaks at approximately 505, 537, 565 and 615 millimicrons.

Infrared spectrophotometry (FIGURE 3 and FIGURE 3A) of the new drug dispersed in potassium bromide, reveals a broad peak associated with hydrogen stretching, said peak centered at approximately 3.0 microns, and a shoulder at approximately 3.4 microns. Finer peaks are observed at approximately 6.4, 7.1, 8.1, 9.4, 12 and 15 microns.

Elemental analysis of the disodium salt derivative of the new drug shows it to have an empirical formula of $C_{34}H_{35-36}N_4O_{5-6}Na_2$, there being some uncertainty in hydrogen and oxygen due to traces of water which cannot be removed from the drug. A carbon-13 nuclear magnetic resonance study (FIGURE 4) of the drug in completely deuterated dimethylsulfoxide shows peaks at approximately 9.0 ppm for $-CH_3$, 18.9 ppm for $-CH_2-$, 24.7 ppm for CH_2 , 34.5 ppm for $-CH-$, 62 ppm for CH_2 , 94.5 ppm for $=C$ (methine), 130—145 ppm for ring C, and 171.7 ppm for $C\equiv O$, all ppm being relative to dimethyl sulfoxide resonance at about 37.5 ppm. Additional vinyl peaks at approximately 118 and 127 ppm may be representative of the new drug or possibly a contaminant.

When the unfiltered reaction product described on page 7, lines 4—13 of this application, was eluted from a Waters Associates' μ m Bondpak C-18 column using first, successively methanol, water and acetic acid (20:5:1) and then using tetrahydrofuran and water (4:1), four components were found. Three by-products were identified as hematoporphyrin, hydroxyethylvinyldeuteroporphyrin and protoporphyrin by comparison with standards on thin layer chromatography, with Rf values of approximately 0.19; 0.23, and 0.39 respectively (FIGURE 5) using Brinkman SIL silica plates and benzene-methanol-water (60:40:15) as eluent.

The fourth component shown in FIGURE 5A, was the biologically active drug of the invention. Chromatography (FIGURE 6 and FIGURE 6A) shows that exclusion of the above-identified impurities using the Milli-Pore Pellicon cassette system fitted with a 10,000 molecular weight filter pack, has occurred, during processing of the drug of the invention.

The biologically active drug of this invention is probably an aggregate of ether molecules formed between two hematoporphyrin molecules by linkage of the hydroxyethylvinyl groups as shown in FIGURE 7. This linkage may occur through hydroxyethylvinyl groups in position 3- or 8- as numbered in FIGURE 7. Linkage may be achieved at position 3- in both halves of the ether, at position 8- in both halves of the ether or through position 3- in one half of the ether and in position 8- in the other half of the ether.

These structures may be named as derivatives of ethyl ether, i.e.:

Bis-1-(3-(1-hydroxyethyl)deuteroporphyrin-8-yl) ethyl ether, as shown in FIGURE 7.

Other structured isomers may be named; 1-(3-(1-hydroxyethyl)deuteroporphyrin-8-yl)-1'-(8-(1-hydroxyethyl)deuteroporphyrin-3-yl)ethyl ether, or 1-(8-(1-hydroxyethyl)deuteroporphyrin-3-yl)-1' (3-hydroxyethyl)deuteroporphyrin-8-yl)ethyl ether, and

Bis-1-(8-(1-hydroxyethyl)deuteroporphyrin-3-yl)ethyl ether.

One or both hydroxyethyl groups at positions 3- or 8-, not used in ether formation, may dehydrate to form vinyl groups. Although experiments have not been conducted, experience indicates that ethers as shown in FIGURE 7 might be substituted with various combinations of hydrogen, alkyl groups, carboxylic acid groups and alcohol-containing groups at various locations of the structure. In addition, many possible optical isomers of these structures exist.

A carbon-13 nuclear magnetic resonance study (FIGURES 8 and 8A) of the drug in deuterated chloroform referenced to tetramethylsilane reveals two additional absorbances not previously apparent in FIGURE 4. Peaks at 24.7 ppm and 62 ppm in FIGURE 4 have shifted to 25.9 ppm and 65.3 ppm respectively in FIGURE 8A but newly-developed peaks at 27.9 ppm and 68.4 ppm in FIGURE 8A represent resonances for CH_2 and $H-C-OH$ bonded from position 3- in FIGURE 8A, respectively. These newly-developed resonances substantiate the molecular formula depicted in FIGURE 7.

While tests using the new drug have been performed to date on animals, it is believed that equivalent results would and will be obtained on humans, utilizing the same or less relative amount of drug to body weight. It is believed that the aforescribed treatment utilizing the drug of the invention, can be used repeatedly without cumulative damage to normal tissues, providing that treatment is not overly aggressive.

While the aforementioned animal tests utilized a dosage of the new drug of approximately 4 mg/kg of

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body weight, in the treatment of the tumors in humans, dosages as low as 1 mg/kg of body weight are believed effective utilizing the new drug. In any event dosages of the new drug of only approximately one-half of the necessary prior art dosages of the prior art related porphyrin drug, are equivalently effective in accomplishing necrosis of tumors.

- 5 Also, while the aforementioned animal tests utilized illumination one day following injection of the new drug, it is believed that a delay of up to seven days prior to illumination still will accomplish necrosis, and a time delay of two to four days between injection and illumination is generally preferable in humans.

Furthermore, while an intensity of 160 mw/cm² for 30 minutes was utilized to activate the drug, it is believed that an intensity as high as 4000 mw/cm² for 20 minutes or as low as 5 mw/cm² for an extended
10 period of time may be utilized to accomplish necrosis. Less than 5 mw/cm² of illumination intensity will probably have no therapeutic effect, irrespective of time of application.

From the foregoing description, and accompanying drawings, it will be seen that the invention provides a new and novel drug, useful in the diagnosis and treatment of tumors, permitting utilization of reduced amounts of the drug as compared to related prior art drugs, and which results in less severe side
15 effects.

Claims

1. A composition of matter effective for localizing and/or destroying tumors, said composition being
20 fluorescent and photosensitive and having the capability of localizing in and being retained in tumor cells as compared to normal tissues, whereby the composition is comprised of high molecular aggregates of a porphyrine derivative, said composition further having a visible spectrum with absorption peaks at 505, 537, 565, and 615 nm, an infrared spectrum with absorption peaks at 3.0, 3.4, 6.4, 7.1, 8.1, 9.4, 12 and 15 microns, a carbon-13 NMR resonance spectrum at 9.0, 18.9, 24.7, 34.5, 62, 94.5, 130—145, and 171.7 ppm
25 relative to a 37.5 ppm resonance for DMSO, and a mass spectrum showing mass numbers of 1899, 1866, 1809, 1290, 1200, 609, 591, 219, and 149 obtainable by
 - a) reacting hematoporphyrine with acetic/sulfuric acid and precipitating the resulting derivate,
 - b) adjusting the pH of an aqueous suspension of said derivative to 7 to 7.4 and
 - c) recovering high molecular aggregates of the derivative by filtration through a membrane system
30 excluding substances with a molecular weight below 10,000.
2. A pharmaceutical composition containing the composition of matter of claim 1 as active ingredient.
3. Pharmaceutical composition of claim 2, characterized in that the active ingredient is present in a concentration of 2.5 mg/cc of aqueous solution.
4. A process for preparing the composition of claim 1 by reacting hematoporphyrine with acetic/
35 sulfuric acids to form a solution of hematoporphyrine derivative and precipitating said derivative from the solution with sodium acetate, characterized in that the hematoporphyrine derivative is subsequently suspended in water, the pH of the aqueous suspension is adjusted to 7.0 to 7.4, and the resulting solution is filtered through a membrane system excluding substances with a molecular weight below 10,000.
5. A process according to claim 4, characterized in that prior to the filtration step sodium chloride is
40 added to the solution in an amount sufficient to render the solution isotonic.

Patentansprüche

1. Eine Stoff-Zusammensetzung zur Lokalisierung und/oder Zerstörung von Tumoren, wobei die
45 genannte Zusammensetzung fluoreszierend und photosensitiv ist und die Fähigkeit besitzt, Tumorzellen im Vergleich zu normalen Geweben zu lokalisieren und in ihnen zurückgehalten zu werden, wobei die Zusammensetzung hochmolekulare Aggregate eines Porphyrinderivats enthält, die genannte
50 Zusammensetzung ferner ein sichtbares Spektrum mit Absorptionsmaxima bei 505, 537, 565 und 615 nm, ein Infrarotspektrum mit Absorptionsmaxima bei 3,0, 3,4, 6,4, 7,1, 8,1, 9,4, 12 und 15 Mikrometer, ein Kohlenstoff-13-NMR-Resonanzspektrum bei 9,0, 18,9, 24,7, 34,5, 62, 94,5 130—145 und 171,7 ppm, bezogen auf eine Resonanz von 37,5 ppm für DMSO, und ein Massenspektrum mit Massezahlen von 1899, 1866, 1809, 1290, 1200, 609, 591, 219 und 149 hat, erhältlich durch
 - a) Umsetzen von Hematoporphyrin mit Essig-/Schwefelsäure und Fällen des resultierenden Derivats,
 - 55 b) Einstellen des pH einer wäßrigen Suspension des genannten Derivats auf 7 bis 7,4 und
 - c) Rückgewinnen hochmolekularer Aggregate des Derivats durch Filtration durch ein Membransystem, das Substanzen mit einem Molekulargewicht unter 10 000 ausschließt.
2. Eine pharmazeutische Zusammensetzung, die als Wirkstoff die Stoff-Zusammensetzung nach Anspruch 1 enthält.
3. Pharmazeutische Zusammensetzung nach Anspruch 2, dadurch gekennzeichnet, daß der Wirkstoff in
60 einer Konzentration von 2,5 mg/ml wäßriger Lösung vorliegt.
4. Ein Verfahren zur Herstellung der Zusammensetzung nach Anspruch 1 durch Umsetzen von Hematoporphyrin mit Essig-Schwefelsäuren zur Bildung einer Lösung von Hematoporphyrin-derivat und Fällen des genannten Derivats aus der Lösung mit Natriumacetat, dadurch gekennzeichnet, daß das
65 Hematoporphyrinderivat nachfolgend in Wasser suspendiert wird, der pH der wäßrigen Suspension auf 7,0

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bis 7,4 eingestellt wird und die resultierende Lösung durch ein Membransystem filtriert wird, das Substanzen mit einem Molekulargewicht unter 10 000 ausschließt.

5. Ein Verfahren nach Anspruch 4, dadurch gekennzeichnet, daß der Lösung vor dem Schritt der Filtration Natriumchlorid in einer Menge zugesetzt wird, die ausreicht, um die Lösung isotonisch zu machen.

Revendications

1. Composition d'une matière efficace pour localiser et/ou détruire les tumeurs, ladite composition étant fluorescente et photosensible et possédant la capacité de se localiser et d'être retenue dans les cellules tumorales par comparaison avec les tissus normaux, caractérisée en ce que la composition est composée d'agrégats de haut poids moléculaire d'un dérivé de la porphyrine, ladite composition ayant, en outre, un spectre visible comportant des pics d'absorption à 505, 537, 565 et 615 nm, un spectre infra-rouge comportant des pics d'absorption à 3,0, 3,4, 6,4, 7,1, 8,1, 9,4, 12 et 15 microns, un spectre de résonance RMN du carbone 13 à 9,0, 18,9, 24,7, 34,5 62, 94,5, 130—145 et 171,7 ppm par rapport à une résonance à 37,5 ppm pour le DMSO, et un spectre de masse montrant des nombres de masse de 1899, 1866, 1809, 1290, 1200, 609, 591, 219 et 149, et peut être obtenue par

a) mise en réaction de d'hématoporphyrine avec un mélange d'acide acétique et sulfurique et précipitation du dérivé résultant

b) ajustement du pH d'une suspension aqueuse dudit dérivé à 7 à 7,4 et

c) récupération d'agrégats de haut point moléculaire du dérivé par filtration à travers un système membranaire excluant des substances ayant un poids moléculaire inférieur à 10 000.

2. Composition pharmaceutique contenant la composition de matière de la revendication 1 en tant qu'ingrédient actif.

3. Composition pharmaceutique selon la revendication 2, caractérisée en ce que l'ingrédient actif est présent à une concentration de 2,5 mg/cm³ de solution aqueuse.

4. Procédé de préparation de la composition selon la revendication 1 par mise en réaction de l'hématoporphyrine avec un mélange d'acides acétique et sulfurique pour former une solution d'une dérivé d'hématoporphyrine et précipitation dudit dérivé à partir de la solution avec de l'acétate de sodium, caractérisé en ce que le dérivé d'hématoporphyrine est ultérieurement mis en suspension dans de l'eau, le pH de la suspension aqueuse est ajusté à 7,0 à 7,4 et la solution résultante est filtrée à travers un système membranaire excluant des substances ayant un poids moléculaire inférieur à 10 000.

5. Procédé selon la revendication 4, caractérisé en ce que avant l'étape de filtration, on ajoute du chlorure de sodium à la solution en une quantité suffisante pour rendre la solution isotonique.

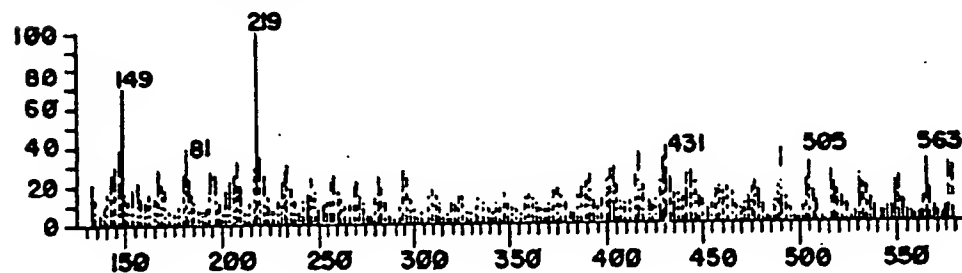
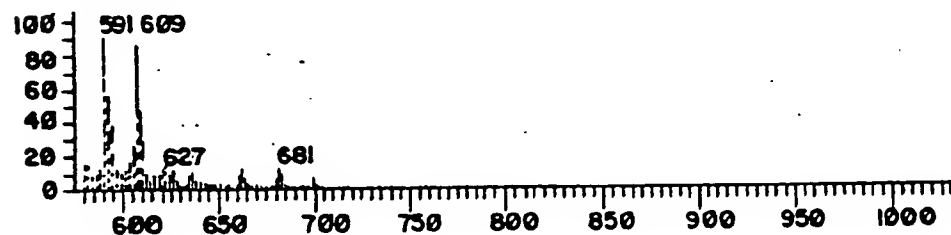
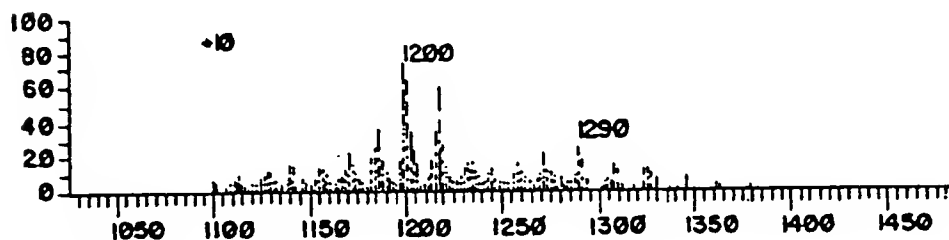
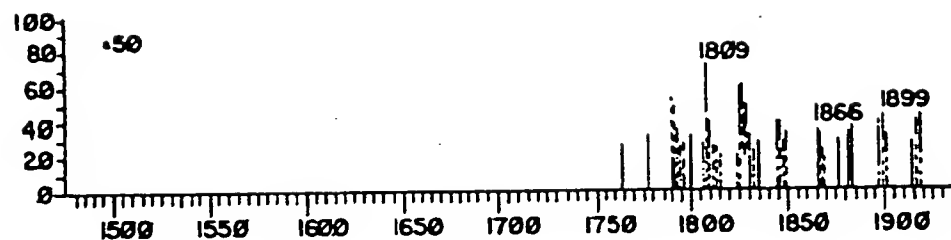
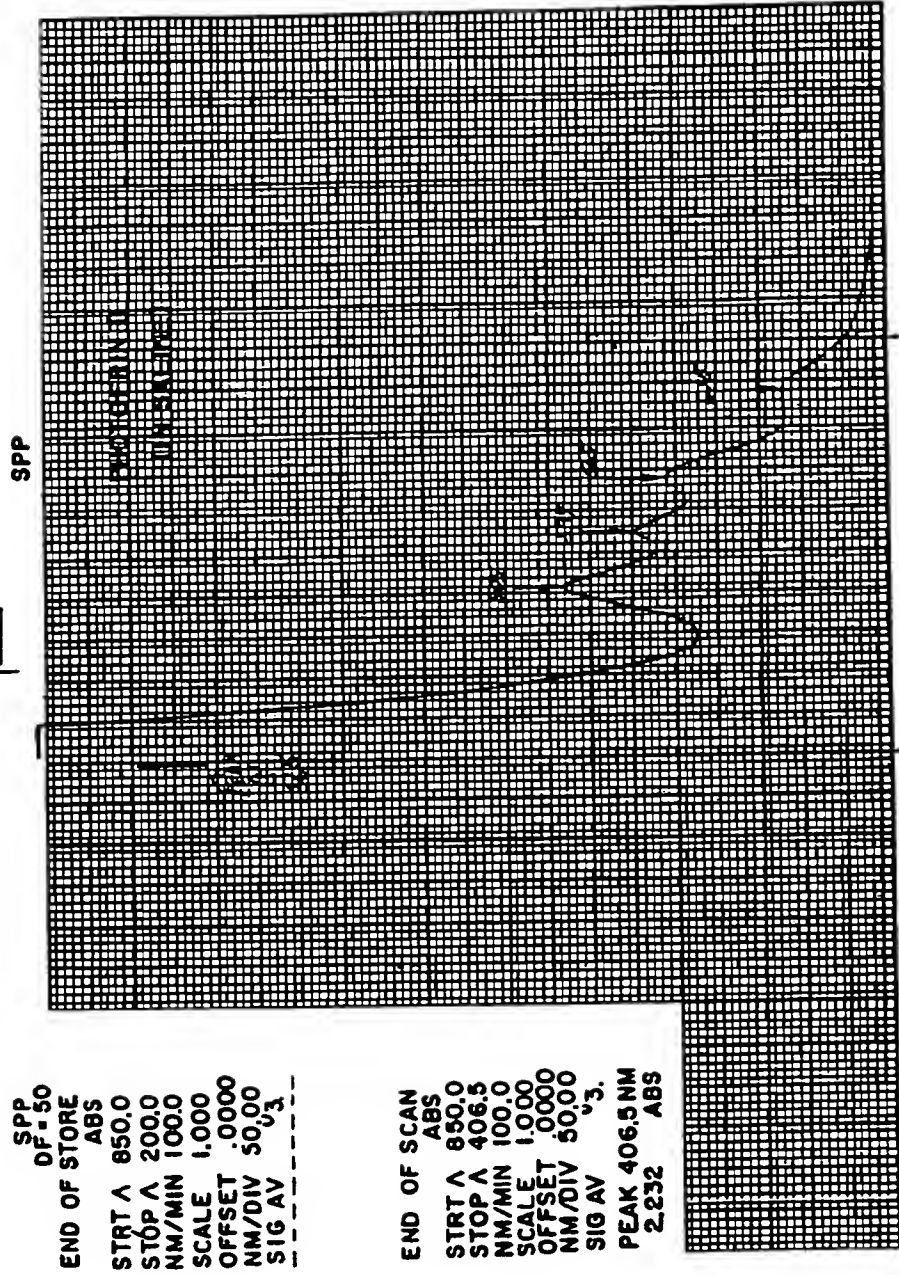


Fig 1

Fig 2



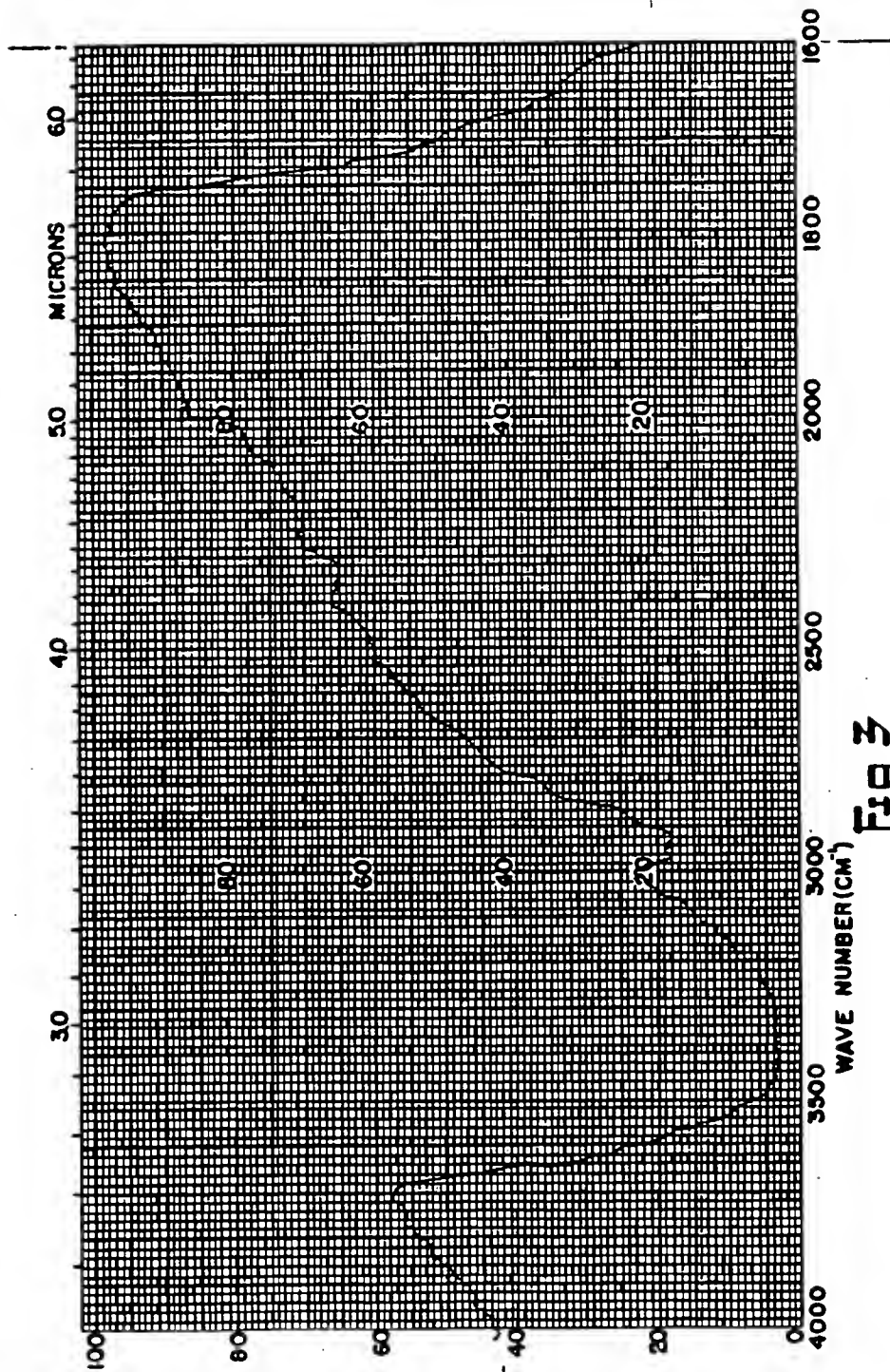


Fig 3

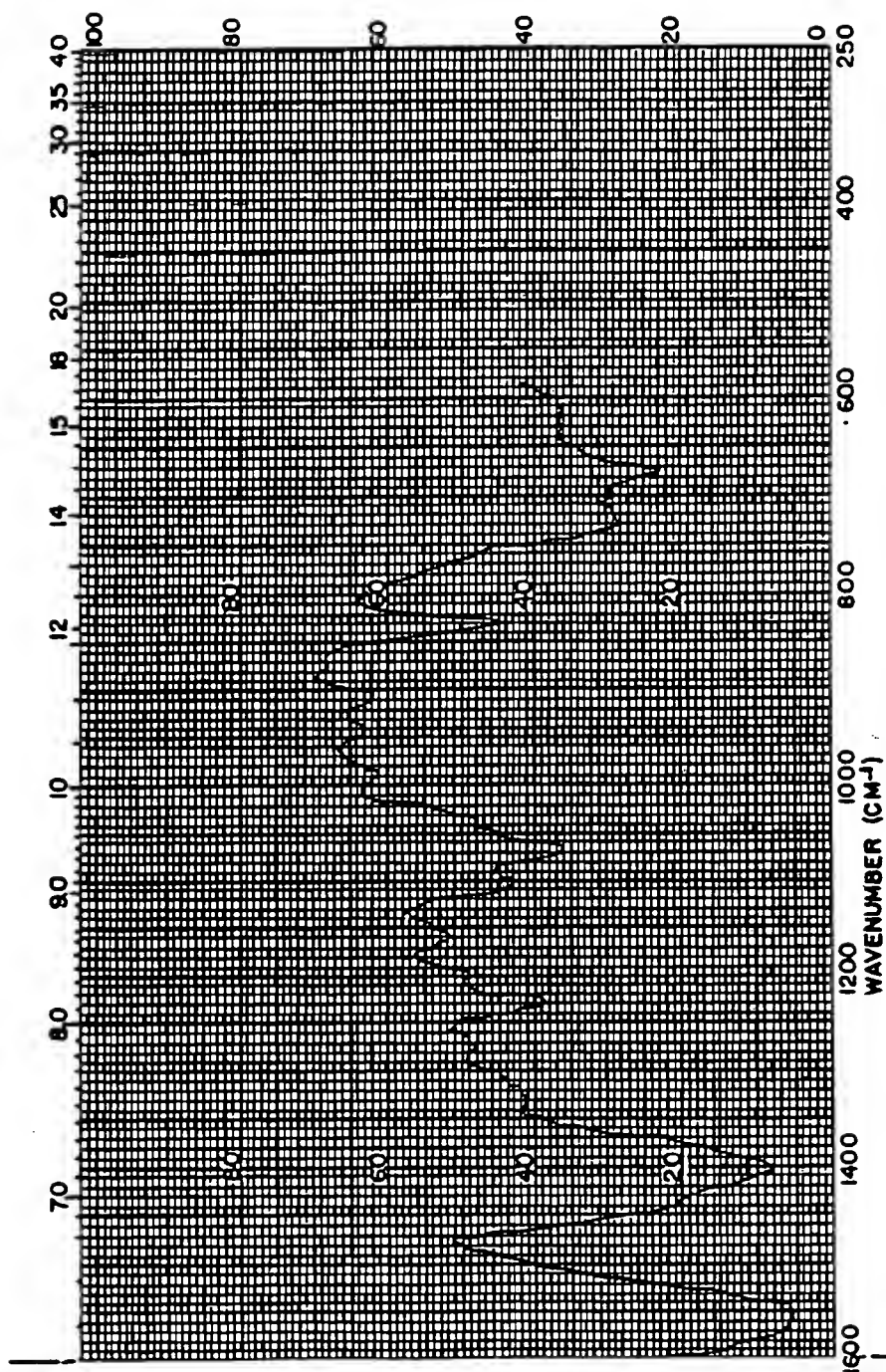
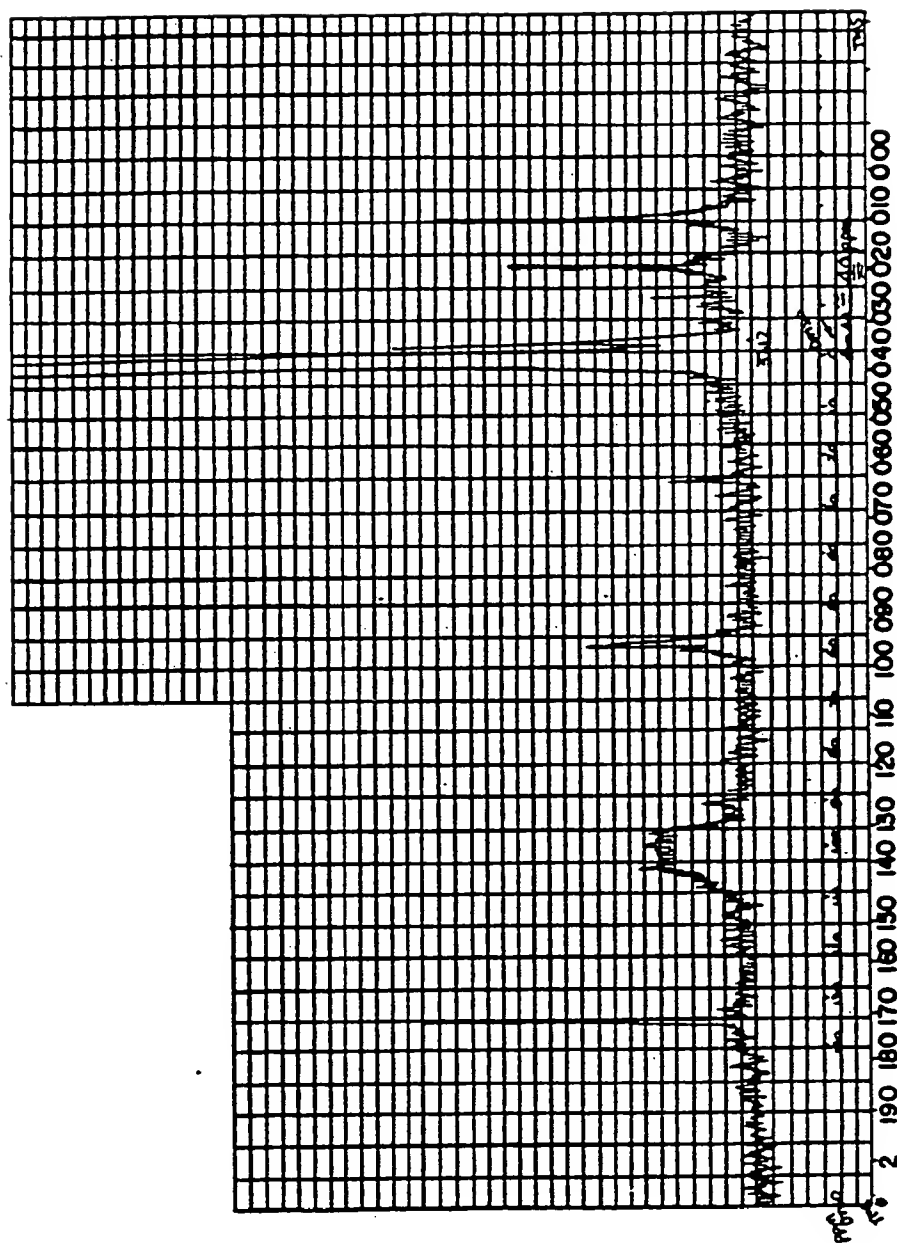


Fig 3A



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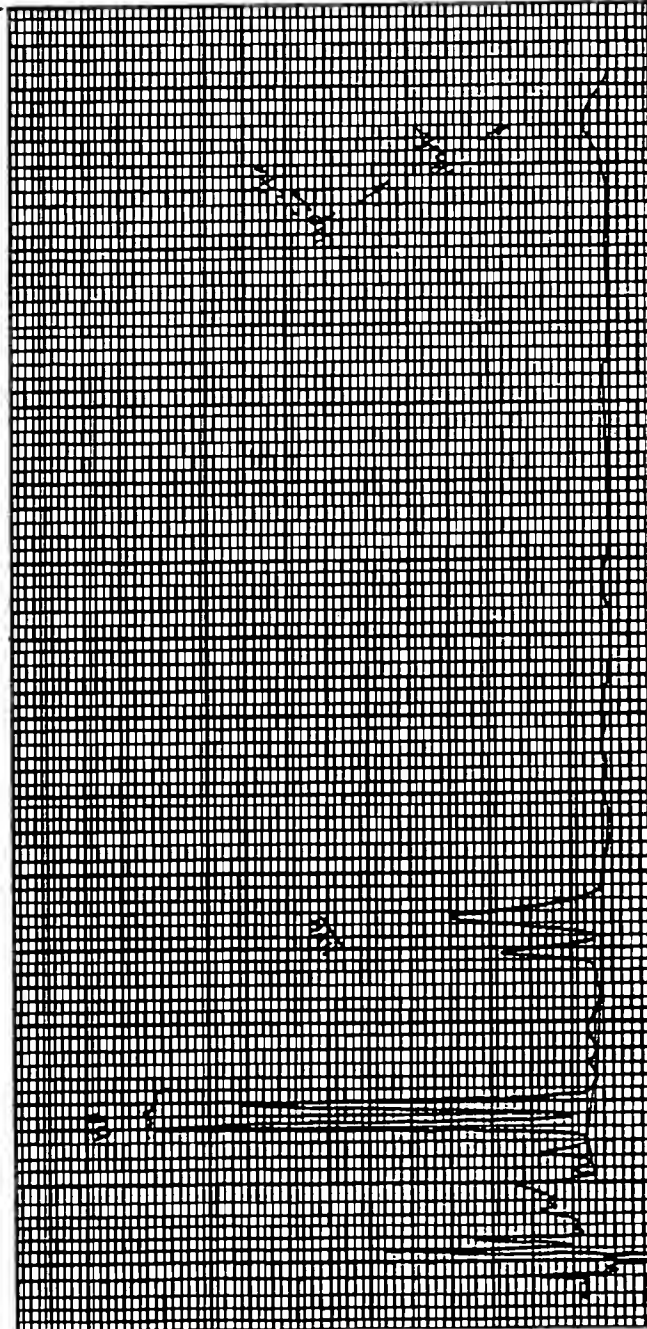


Fig 5

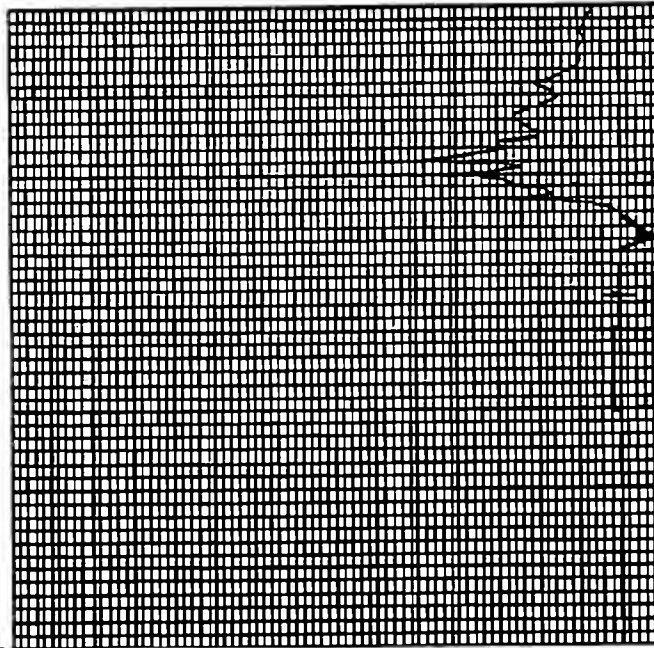


Fig 5A

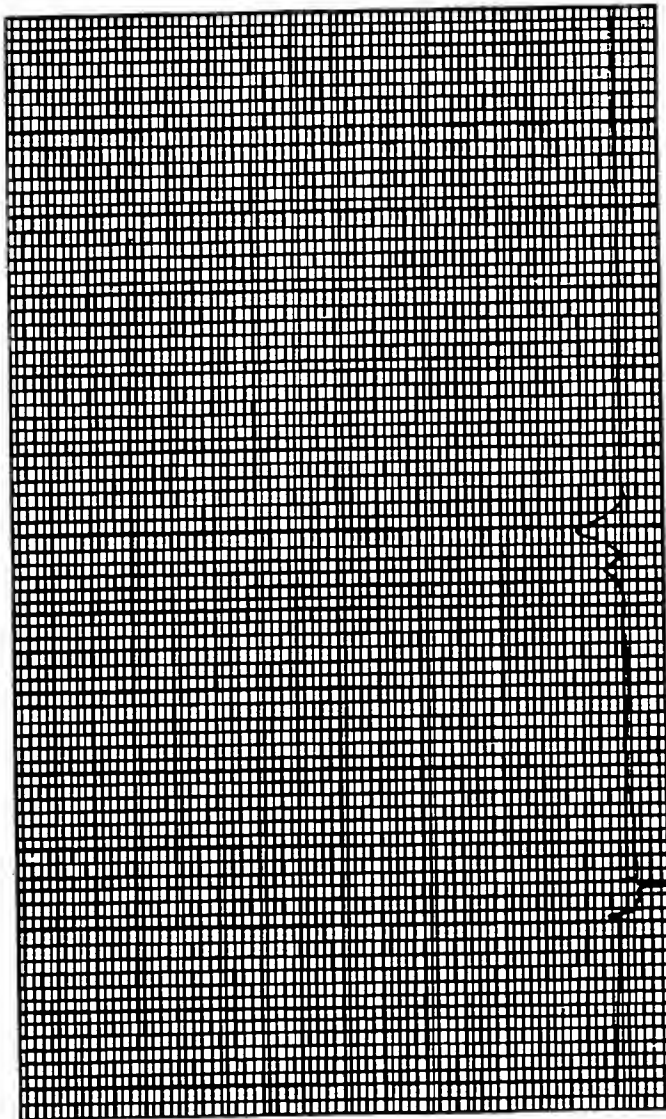


Fig 6

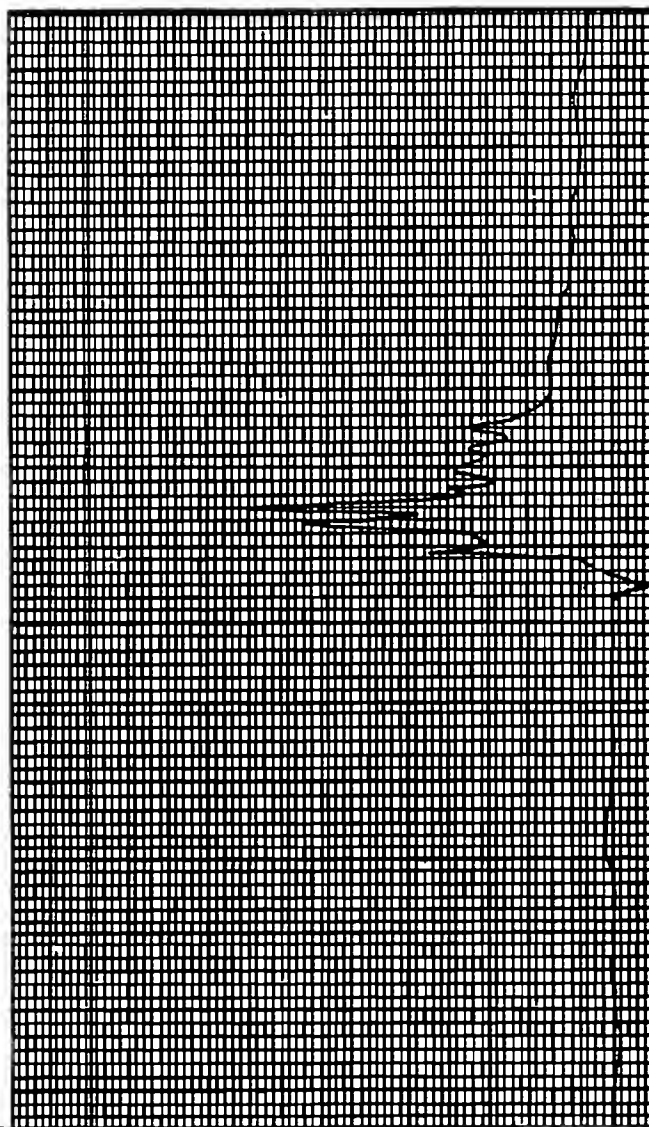


Fig 6A

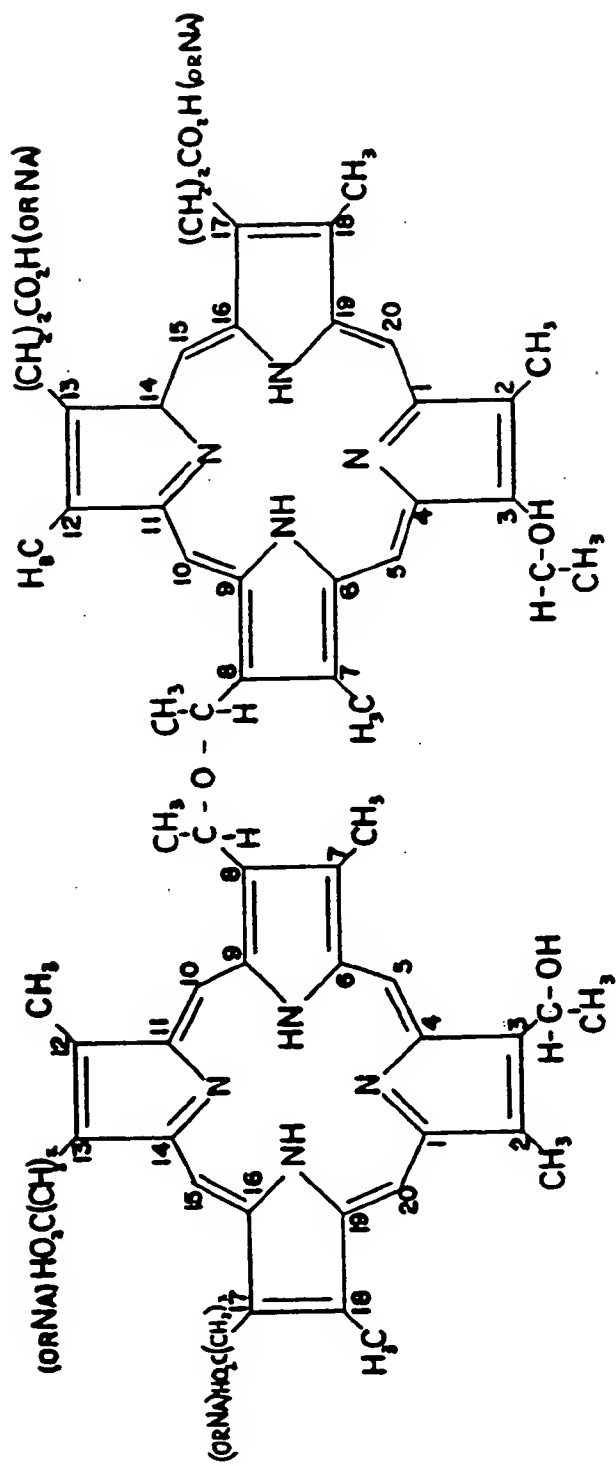
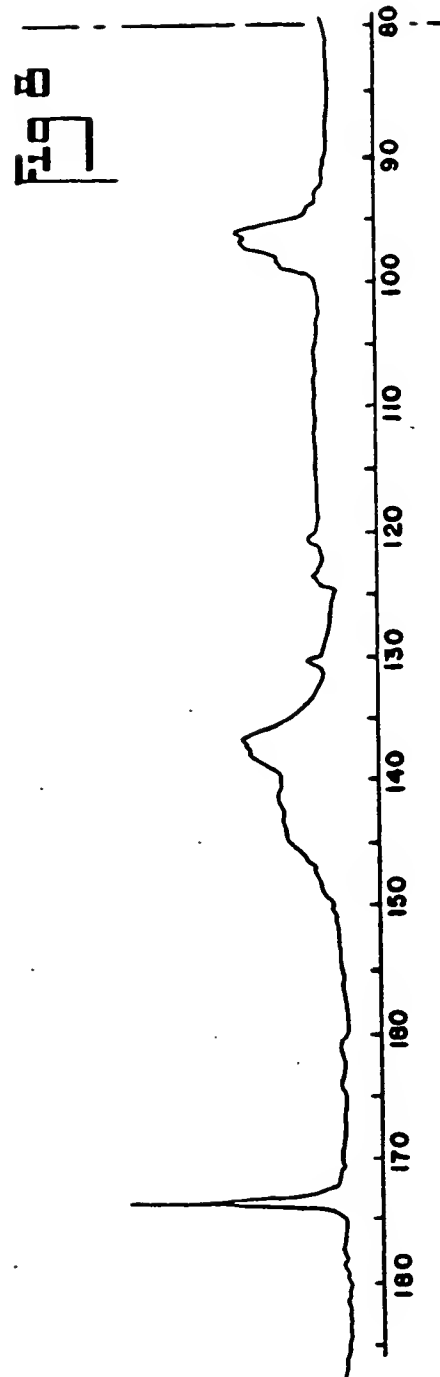
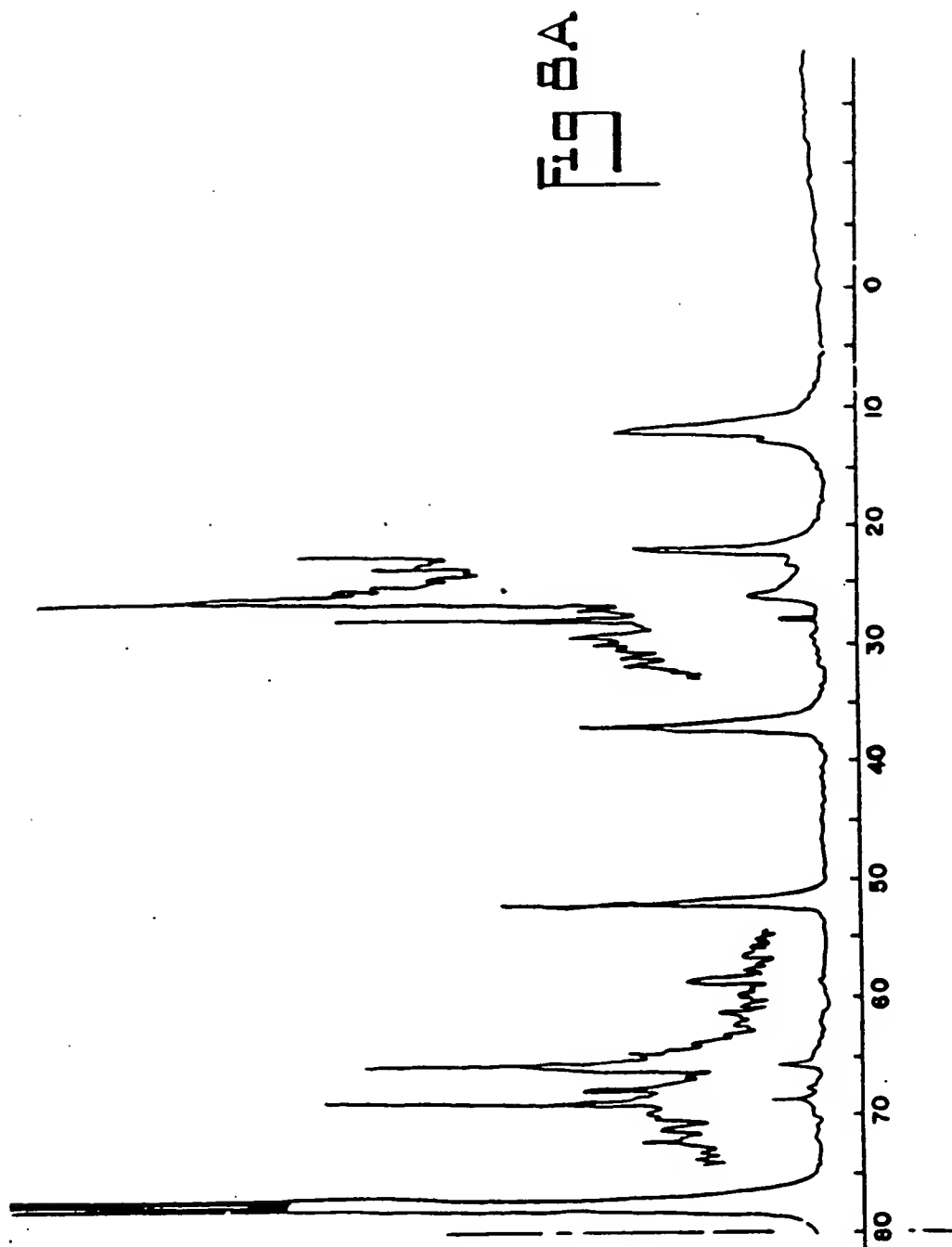


Fig 7

EP 0 120 054 B1





0 120 054



European Patent
Office

SUPPLEMENTARY EUROPEAN SEARCH REPORT

Application number

EP 83 90 3067

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
X	CHEMICAL ABSTRACTS, vol. 97, no. 1, July 5, 1982, page 394, abstract 3930s, COLUMBUS, OHIO (US), SHILIN XU et al.: "Hematoporphyrin sodium, as a chemotherapeutic agent", & Zhongcaoyao 1981, 12(8), 343-4. * the whole abstract *	1-35	C 07 D 209/58 A 61 K 31/40
X	--- CHEMICAL ABSTRACTS, vol. 78, no. 11, March 19, 1973, page 212, abstract 68960d, COLUMBUS, OHIO (US), D.R. SANDERSON et al.: "Hematoporphyrin as a diagnostic tool. Preliminary report of new techniques". & Cancer (Philadelphia) 1972, 30(5), 1368-72. * the whole abstract *	1-35	
P, X	--- CHEMICAL ABSTRACTS, vol. 98, no. 9, February 28, 1983, page 293, abstract 68090h, COLUMBUS, OHIO (US), C.J. GOMER et al.: "Hematoporphyrin derivative photoradiation therapy for the treatment of intraocular tumors; examination of acute normal ocular tissue toxicity". & Cancer Res. 1983, 43(2), 721-7. * the whole abstract *	1-35	C 07 D 487/00 C 07 D 519/00
<p>TECHNICAL FIELDS SEARCHED (Int. Cl. 4)</p>			
<p>The supplementary search report has been drawn up for the claims attached hereto.</p>			
Place of search THE HAGUE		Date of completion of the search 19-12-1984	Examiner MAISONNEUVE J.A.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p>		<p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>	

EP Form 1506-03/82

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Claims

1. A substance effective for localizing and/or
destroying tumors, said substance being fluor-
escent and photosensitive, and having the capa-
5 bility of localizing in and being retained in
tumor cells as compared to normal tissues, said
substance being a high molecular weight aggre-
gate of a porphyrin derivative, said substance
having adsorption peaks in the visible spectrum
10 at approximately 505, 537, 565 and 615 milli-
microns, said substance having adsorption peaks
in the infrared spectrum at approximately 3.0,
3.4, 6.4, 7.1, 8.1, 9.4, 12 and 15 microns,
said substance having adsorption peaks in carbon-13
15 nuclear magnetic resonance study at approximately
9.0, 18.9, 24.7, 34.5, 62, 94.5, 130-145, 171.7 ppm
and possibly 118 and 127 relative to a 37.5 ppm
resonance peak of dimethyl sulfoxide.
2. A substance in accordance with claim 1 wherein
20 said substance shows mass numbers of 1899, 1866,
1809, 1290, 1200, 609, 591, 219 and 149 according
to mass spectroscopy.
3. A substance in accordance with claim 1 wherein
said substance is in liquid form having a concen-
25 tration of approximately 2.5 mg/cc.
4. A substance in accordance with claim 3 wherein
said liquid form includes isotonic saline solu-
tion at a pH of approximately 7.0 to 7.2.
5. A substance in accordance with claim 1 wherein
30 the substance is orange-red in color.



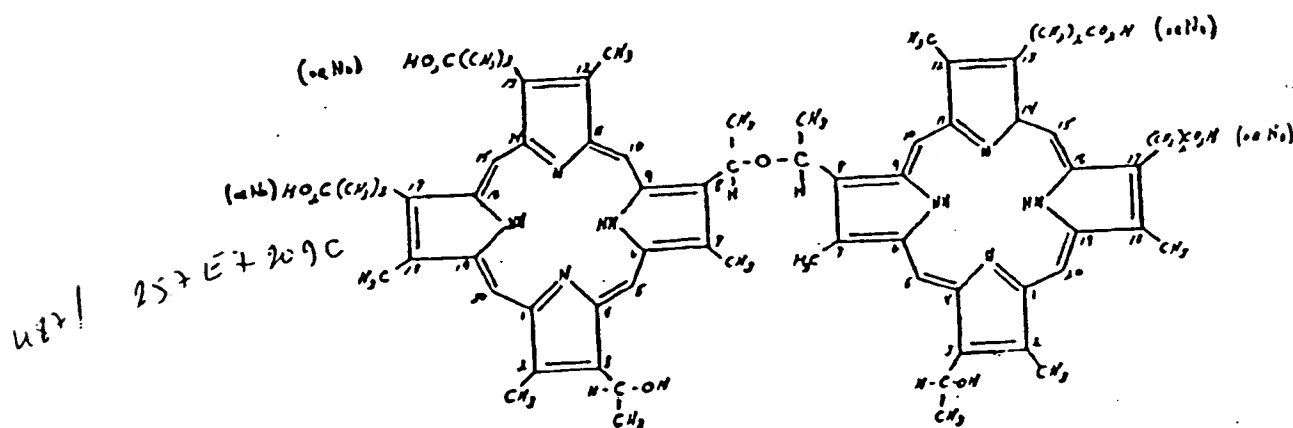
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6. A substance in accordance with claim 1 wherein said substance has an empirical formula of approximately $C_{34} H_{35-36} N_4 O_{5-6} Na_2$.
7. A process for the production and purification of the substance defined in claim 1, which comprises, reacting hematoporphyrin with acetic/sulfuric acids to form a solution, precipitating the crude product by neutralization in sodium acetate, dissolving the crude product with sodium hydroxide, adjusting the acidity of the solution to pH of 7.0-7.2 with hydrochloric acid, and passing the resultant impure solution through a porous membrane system to exclude low molecular weight by-products thereby effecting purification.
8. A process in accordance with claim 7 including adding sodium chloride to said impure solution to make the latter isotonic prior to passing it through said membrane system.
9. A process in accordance with claim 7 wherein said substance in solution has a concentration of approximately 2.5 mg/cc and is adjusted to obtain said concentration by addition or removal of liquid.
10. A process in accordance with claim 7 wherein ambient temperatures are substantially maintained throughout said process.
11. A process for the in vivo destruction of tumor cells using the substance of claim 1, which comprises injecting said substance into a host, waiting for a predetermined period of time, and then illuminating the host with light at predetermined intensity.



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12. A process in accordance with claim 11 wherein said substance is used in a dosage of from about 1 to 4 mg/kg of body weight of the host.
13. A process in accordance with claim 11 wherein the time delay between injection and illumination is within a range of about 1 to 7 days.
14. A process in accordance with claim 11 wherein said intensity of illumination is at least 5mw/cm^2 for an extended period of time, but no greater than 4000mw/cm^2 for twenty minutes.
15. A process in accordance with claim 11 wherein said substance is used in a dosage of about 4 mg/kg of body weight of the mouse, said intensity of illumination is about 160mw/cm^2 for a period of about thirty minutes, the time delay between injection and illumination being approximately 24 hours.
16. A process in accordance with claim 11 wherein said illumination is red light having a wave length between $6000-7000\text{\AA}$.
17. A substance having the molecular formula



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- effective for localizing and/or destroying tumors, said substance being fluorescent and photosensitive, and having the capability of localizing in and being retained in tumor cells as compared to
- 5 normal tissues, said substance being a high molecular weight aggregate of a porphyrin derivative, said substance having adsorption peaks in the visible spectrum at approximately 505, 537, 656 and 615 millimicrons, said substance having
- 10 adsorption peaks in the infrared spectrum at approximately 3.0, 3.4, 6.4, 7.1, 8.1, 9.4, 12 and 15 microns, said substance having adsorption peaks in carbon-13 nuclear magnetic resonance study at approximately 9.0, 18.9, 24.7, 34.5, 62,
- 15 94.5, 130-145, 171.7 ppm and possibly 118 and 127 relative to a 37.5 ppm resonance peak of dimethyl sulfoxide, said substance also having additional adsorption peaks in carbon-13 nuclear magnetic study at approximately 27.9 ppm and 68.4
- 20 ppm relative to the resonance peak of tetramethylsilane in deuterated chloroform solvent.
18. A substance in accordance with claim 17 wherein said substance shows mass numbers of 1899, 1866, 1809, 1290, 1200, 609, 591, 219 and 149 according
- 25 to mass spectroscopy.
19. A substance in accordance with claim 17 wherein said substance is in liquid form having a concentration of approximately 2.5 mg/cc.
20. A substance in accordance with claim 19 wherein
- 30 said liquid form includes isotonic saline solution at a pH of approximately 7.0 to 7.2.



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21. A substance in accordance with claim 17 wherein the substance is orange-red in color.
22. A substance in accordance with claim 17 wherein said substance has an empirical formula of approximately $C_{68}H_{70}N_8O_{11}(Na \text{ plus } H)_4$.
23. A process for the production and purification of the substance defined in claim 17, which comprises, reacting hematoporphyrin with acetic/sulfuric acids to form a solution, precipitating the crude product by neutralization in sodium acetate, dissolving the crude product with sodium hydroxide, adjusting the acidity of the solution to pH of 7.0-7.2 with hydrochloric acid, and passing the resultant impure solution through a porous membrane system to exclude low molecular weight by-products thereby effecting purification.
24. A process in accordance with claim 23 including adding sodium chloride to said impure solution to make the latter isotonic prior to passing it through said membrane system.
25. A process in accordance with claim 23 wherein said substance in solution has a concentration of approximately 2.5 mg/cc and is adjusted to obtain said concentration by addition or removal of liquid.
26. A process in accordance with claim 23 wherein ambient temperatures are substantially maintained throughout said process.



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27. A process for the in vivo destruction of tumor cells using the substance of claim 17, which comprises injecting said substance into a host, waiting for a predetermined period of time, and then illuminating the host with light at pre-determined intensity.
28. A process in accordance with claim 27 wherein said substance is used in a dosage of from about 1 to 4 mg/kg of body weight of the host.
29. A process in accordance with claim 27 wherein the time delay between injection and illumination is within a range of about 1 to 7 days.
30. A process in accordance with claim 27 wherein said intensity of illumination is at least 5mw/cm^2 for an extended period of time, but no greater than 4000mw/cm^2 for twenty minutes.
31. A process in accordance with claim 27 wherein said substance is used in a dosage of about 4 mg/kg of body weight of the mouse, said intensity of illumination is about 160mw/cm^2 for a period of about thirty minutes, the time delay between injection and illumination being approximately 24 hours.
32. A process in accordance with claim 27 wherein said illumination is red light having a wave length between 6000-7000Å.
33. A substance in accordance with claim 17 which is substituted with one or more hydrogen, alkyl groups, carboxylic acid groups and alcohol-containing groups at various locations of the structure.



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34. An injectable drug dosage of approximately 1 to 4 mg/kg of body weight of the host and comprising a substance effective in said dosage amount for localizing and/or destroying tumors, said substance being fluorescent and photosensitive, and having the capability of localizing in and being retained in tumor cells as compared to normal tissues, said substance being a high molecular weight aggregate of a porphyrin derivative, said substance having adsorption peaks in the visible spectrum at approximately 505, 537, 565 and 615 millimicrons, said substance having adsorption peaks in the infrared spectrum at approximately 3.0, 3.4, 6.4, 7.1, 8.1, 9.4, 12 and 15 microns, said substance having adsorption peaks in carbon-13 nuclear magnetic resonance study at approximately 9.0, 18.9, 24.7, 34.5, 62, 94.5, 130-145, 171.7 ppm and possibly 118 and 127 relative to a 37.5 ppm resonance peak of dimethyl sulfoxide.
35. A drug dosage in accordance with claim 34 wherein activation of said drug after injection of said dosage into the host is accomplished by subjecting the host to illumination with red light having a wave length of between 6000-7000Å to activate said drug.

